Organisms & their Environment

IGCSE Biology ▪ Topic 19

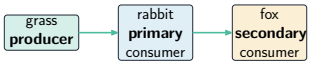
IGCSE Biology

What we will cover

the carbon cycle

1 Feeding

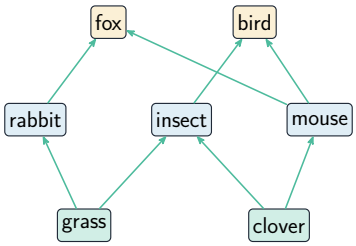
Energy flow and food chains



each arrow shows energy flowing to the next organism

- a **population** 种群 is a group of organisms of one **species** 物种, living in the same area at the same time.
- a **community** 群落 is all the populations of different species in one place.
- an **ecosystem** 生态系统 is the community together with its **environment**, all interacting.

Food webs and feeding roles

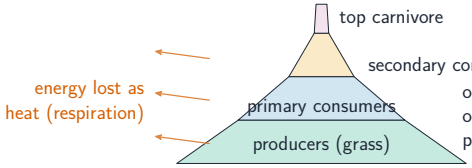


A **food chain** 食物链 shows the transfer of energy from one organism to the next, starting with a producer.

> Each arrow points in the direction the energy flows: grass → rabbit → fox A **food web** 食物网 is many food chains linked together.

Pyramids and energy loss

Each **trophic level** 营养级 passes only ~10% of its energy up, so levels shrink & chains are short. A **pyramid of numbers** 数量金字塔 counts organisms and can come out the wrong shape – one oak tree feeding many insects. A **pyramid of biomass** 生物量金字塔 weighs them, which is usually the better picture. Eating crops directly wastes less than eating animals; humans harm webs by **overharvesting** 过度捕捞.



only about **10%** of the energy passes up each level

Human impact

- **overharvesting** 过度捕捞 – taking too many of one species (such as overfishing), so its numbers crash.
- introducing a **foreign species** 外来物种 – a new species may have no predators and may crowd out native species.

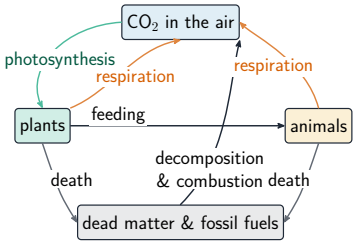
Why eating plants feeds more people

Energy is lost	Only about 10% of the energy at one trophic level reaches the next – the rest goes in respiration, movement and undigested waste.
So a shorter chain feeds more	It is more energy-efficient for people to eat **crop plants** 农作物 directly than to eat animals fed on those crops.
The carbon side	Photosynthesis removes **carbon dioxide** 二氧化碳 from the air; respiration, decay and combustion put it back.

> "Energy is lost between levels" earns a mark only when you say *where* it went.

2 Cycles

The carbon cycle



Carbon is recycled:

- **photosynthesis** 光合作用 removes CO_2
- over millions of years dead organisms form **fossil fuels** 化石燃料, which return that carbon when burned
- respiration & **combustion** 燃烧 return it
- **decomposition** 分解 & fossil fuels too

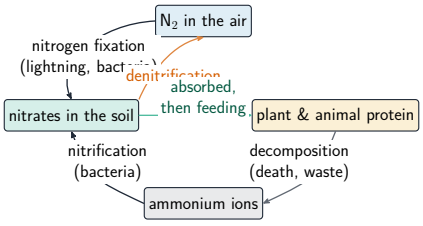
The nitrogen cycle

Microorganisms 微生物 move nitrogen:

- **nitrogen fixation** 固氮作用 – N_2 to nitrates
- **nitrification** 硝化作用 – ammonium to nitrate
- **denitrification** 反硝化作用 – nitrate back to N_2
- **deamination** 脱氨基作用 in the liver, and decomposition, release nitrogen compounds again

Plants absorb nitrates for protein.

The nitrogen cycle, in detail



> The nitrogen cycle: microorganisms move nitrogen between the air, soil and living things

Four steps, four kinds of bacteria

Nitrogen fixation	Bacteria in root nodules and in the soil turn atmospheric N_2 into ammonium ions – lightning does a little too.
Nitrification	Bacteria change ammonium ions into **nitrate ions** 硝酸根离子, the form roots can absorb.
Assimilation	Plants absorb nitrate ions to make **amino acids** 氨基酸 and proteins; animals get theirs by feeding and **digestion** 消化.
Decay and denitrification	Decomposers return nitrogen from dead matter as ammonium; denitrifying bacteria return N_2 to the air.

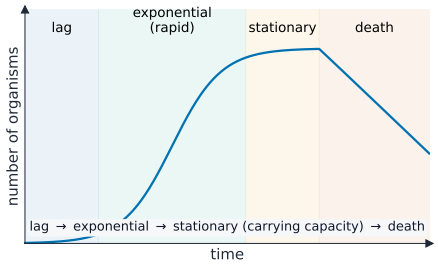
> Name the bacteria *and* the ion at each step. "Bacteria change it" is the answer that scores nothing.

3 Populations

Populations

A **population** 种群 is one species in one area; a **community** 群落 is all of them; with the environment it is an **ecosystem** 生态系统. Growth runs lag → exponential → stationary → death, and what sets each phase is the food supply, **competition** 竞争, **predation** 捕食 and disease.

Populations, in detail



> A **population** 种群 is one species in one area; a **community** 群落 is all of them; with the environment it is an **ecosystem** 生态系统.

The four phases of a population curve

Lag phase	Slow growth: few individuals, and they are still adjusting to the conditions.
Exponential phase	The **exponential phase** 对数期: very fast growth, with plenty of food and space and few predators.
Stationary phase	Births balance deaths – the population sits at the carrying capacity of the habitat.
Death phase	Food runs out or waste builds up, and numbers fall.

> Every phase is a statement about *limiting factors*, so name the factor that changed at each turn of the curve.

Populations, continued

> A coral reef is a rich ecosystem supporting many interdependent species.

The nitrogen cycle, and the four phases of growth

the nitrogen cycle 氮循环	recycles nitrogen for making **proteins** 蛋白质 and **amino acids** 氨基酸
the microorganisms 微生物	nitrogen-fixing **bacteria** 细菌 make ammonia; nitrifying bacteria make nitrites then nitrates; denitrifying bacteria return N_2 to the air
decomposers	release **ammonium ions** 铵离子 from dead matter and waste
lag phase 延迟期	slow growth at first, while numbers are still small
log phase	rapid exponential growth, with resources plentiful
stationary phase 稳定期	growth stops; births ≈ deaths – a **limiting factor** 限制因素 has taken hold

A **death phase** 衰亡期 follows when waste accumulates or food runs out. Naming which limiting factor ended the log phase is the mark.

Food chains and food webs

A savanna ecosystem: organisms linked by feeding relationships.

Producers, consumers and decomposers

Consumers are named by their position: a **primary** consumer eats the producer; a **secondary** consumer eats the primary consumer.

Exam tips

- Energy enters from the Sun, flows one way along the chain, and is lost as heat at each step. Nutrients are recycled.
- Food chain starts with a producer; arrows show energy flow. Learn producer, consumer, herbivore, carnivore, decomposer.
- Only ~10% of energy passes up each trophic level, so chains are short and eating plants is more efficient.
- Carbon cycle: photosynthesis respiration and combustion; nitrogen cycle (Supplement): fixation, nitrification, denitrification by microorganisms.
- Population: one species, one area, one time. Learn the four phases of the S-shaped growth curve.

4 Recap

Worked example – why food chains are short

Explain why a food chain rarely has more than four or five links.

- Only about 10% of the energy at one level reaches the next.
- The rest is lost as heat from respiration, in faeces, and in urine.
- Some parts are also not eaten (bones, roots).
- After a few links there is too little energy left to support another population.

Energy enters as sunlight and leaves as heat – it flows through, it does not cycle. Nutrients do cycle. That difference is worth marks.

Topic 19 – key takeaways

1. **Energy**
   from the Sun; one way; lost as heat
2. **Pyramids**
   only ∼10% passes up each level
3. **Cycles**
   carbon & nitrogen are recycled
4. **Populations**
   lag, exponential, stationary, death

Organisms & their Environment
└Recap

Check yourself

1. What does a food-chain arrow show?
2. Roughly how much energy passes up a level?
3. Which process removes CO_2 from the air?
4. What are the four phases of population growth?

Answers **1.** the direction energy flows **2.** about 10% **3.** photosynthesis **4.** lag, exponential, stationary, death